

# New York's Food and Life Sciences Bulletin

New York State Agricultural Experiment Station, Geneva, a Division of the New York State College of Agriculture and Life Sciences, A Statutory College of the State University, at Cornell University

## SMALL SCALE, SUSTAINABLE, IPM AND PRODUCTION SYSTEMS FOR APPLES IN ROMANIA

A Cooperative Project between USDA/OICD/RSED,  
Cornell University and University of Massachusetts



*Apple crop on a two-year-old Romanian scab-resistant cultivar grafted on a Malling-9 rootstock.*



*Romanian apple grower standing in a two-year-old planting of scab-resistant apple cultivars.*

Romania, a country in eastern Europe, which is about the size of the state of Wyoming, has a long history of apple production. Production figures during the last several years show that it may be the ninth or tenth largest apple producing country in the world, with about 100,000 hectares of apples. During the last 10 to 20 years, most of the apples from Romania that have been sold outside of local village markets have been produced on large plantings of apples on state-owned farms or cooperatives. Most of the apple planting systems, which were originally adopted from Italian pomologists, are remarkably similar in all of the older established apple orchards on the state farms throughout the country.

Horticultural Research Institutes, which are located in the different fruit production regions, have traditionally generated pomological and plant protection technology for these large state farms. During the last several years, a new government has been attempting to return agriculture to private farmers and decentralize the existing state farms. This has led to significant changes in apple marketing and production on most of the existing apple plantings on sites of former state farms.

Most state farms currently lack financial resources to purchase new equipment, replant older nonproductive orchards, and buy critically needed pesticides. It is also difficult to secure adequate labor to prune orchards properly and thin fruit during the season. Finally, many of the traditional markets for apples in the former Soviet Union no longer exist, and most of the fruit currently produced on the state farms cannot meet the more stringent quality standards required for more sophisticated markets in Western Europe, Japan, or the United States. These constraints, coupled with continuing problems with redistribution of government-owned land among multiple owners with claims to small acreage, make the future for the continued survival and operation of traditional large centralized apple farms in Romania quite bleak.

In contrast to the large state-owned apple plantings, there are multitudes of extremely small plantings of apples in or near small villages scattered throughout the countryside. These small plantings of apples range from 5 to 10 trees near farmers' houses to somewhat larger orchards of 50 to 100 trees. Most of the horticultural technology generated from the research institutes in Romania is inappropriate for these small subsistence plantings of apples, and small farmers usually have access to only limited information from the extension service. In addition, because these farmers lack financial

resources and cannot borrow money at reasonable interest rates, inputs to these traditional plantings are usually limited. These trees are generally unpruned and fruit is rarely thinned, which results in small, poorly colored fruit. Also, a substantial proportion of the fruit is generally infested by insect pests and diseases because farmers cannot purchase adequate amounts of pesticides and their hand operated backpack sprayers usually cannot provide adequate coverage of these dense, relatively large trees, which may be 10 to 12 feet tall. Consequently, most of this fruit is either used for the individual family's consumption, sold for low prices in local markets, or distilled into brandy. Currently, very few small farmers can support themselves solely on income from these small apple plantings.

It is a formidable challenge to develop appropriate pest management and production systems for implementation on these small farms because of the severely limiting constraints, including: extremely limited financial resources; inadequate equipment for spraying trees and cultivating land; limited acreage available for fruit production; and formidable levels of insect pests and disease inoculum emanating from nearby poorly maintained apple trees.

If apple production is to remain a viable and important enterprise in Romania in the future, it is imperative to develop appropriate systems that can be utilized on a relatively small scale as existing horticultural land becomes more equitably distributed among the population into small acreages of potential orchard sites. The development of improved production and pest management systems that would lead to improved fruit quality on small plantings of apples could also provide supplemental financial resources for small farmers who currently are unable to supplement their meager incomes by marketing fruit from their traditional apple plantings.

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*Typical intercropping system of vegetables and apple trees planted by Romanian farmers with limited land resources.*

In the apple production systems in the western United States, a large proportion of the apples are grown on fairly large continuous plantings that may be managed either by large agricultural corporations or farmer cooperatives. In the northeastern United States, most of the apples are grown on small family farms of limited acreage that may be widely scattered throughout a particular state. Because of the diversity and scope of the apple industry in this area, Cornell University and the University of Massachusetts have been working to develop apple Integrated Pest Management (IPM) systems that can be implemented in small orchards by individual farmers. In addition, since one of the primary pest problems throughout the region is a fungal disease, apple scab, Cornell University has been very active during the last 20 years in breeding and releasing new apple cultivars that are resistant to this disease. Although the currently available disease resistant cultivars are not yet widely grown on larger commercial apple farms in the Northeast, they are being planted by homeowners and small apple producers interested in growing fruit under minimal pesticide regimes.

The objectives of this project are: (1) To determine if the simplified apple IPM techniques developed at Cornell University can be utilized in existing small plantings of apples by Romanian growers; and (2) To set up new plantings of dwarf-apple scab resistant cultivars on small farms in Romania and to develop appropriate pest management systems for these orchards utilizing selective, IPM-compatible pesticides. Additionally, the Romanian setting for this project provided an ideal opportunity to test small scale, sustainable apple pest management and production systems that can be implemented in other countries with similar climates and agricultural systems.



*'Palmette' tree training system planted on typical state farm orchards in Romania (dormant growth stage).*



*Typical 'Palmette' planting system of 'Delicious' and 'Golden Delicious' apple trees on a Romanian state farm orchard during the summer.*

## MATERIALS AND METHODS

The project was conducted in several small villages in the central part of Romania near the town of Curtea de Arges. This region is typical of the major apple production regions of Romania near the foothills of the Transylvanian Alps and includes both numerous small apple farms scattered in and around small villages as well as large, formerly state-owned plantings of apples. This area is remarkably well suited for cooperative IPM efforts with research and extension programs in New York state and Massachusetts because the climate, soils, apple rootstocks, apple cultivars, and many major apple pests are quite similar within the two regions. The town of Curtea de Arges was chosen as the headquarters of the project because it was also the site for an agricultural development project operated within the local community development program.

The project was generally designed to provide information delivery to cooperating Romanian growers and test pilot IPM programs in small plots using systems similar to those currently utilized in extension IPM programs at Cornell University and the University of Massachusetts. A multidisciplinary IPM team of entomologists, pomologists, plant pathologists, and IPM field implementation specialists from both universities in the United States and the Plant Protection Institute in Romania was established to design and administer the project.

The general operational plan for the project was for this IPM team to visit the IPM demonstration sites several times throughout the season to train Romanian IPM specialists supported by the project, to hold field meetings to educate Romanian apple growers, and to monitor pest problems in the demonstration orchards. The initial visits were always planned for early spring prior to the beginning of tree growth so that the team could meet with Romanian cooperating scientists and the IPM specialist to plan the entire season's activities and conduct pruning demonstrations for the Romanian apple growers. A second visit occurred during the middle part of the season to monitor progress and problems during the summer. The final IPM team visit was planned for late summer or early fall so that the team could assess the effectiveness of the seasonal control in the project and assist in evaluation of damage and quality of fruit in the demonstration plots.

The project formally began during April of 1993, when a three-member team, consisting of an entomologist, pomologist, and plant pathologist, visited Curtea de Arges to meet with Romanian scientists from the Plant Protection Institute to set up IPM demonstration sites in existing orchards. During this initial visit, the project hired a Romanian pomological student from the University of Bucharest to work part-time in Curtea de Arges throughout the growing season to coordinate project activities and assist farmers in monitoring the IPM plots and applying pesticides when needed.

In 1993, five IPM demonstration sites were set up in existing plantings of apples:

- **Cepari State Farm**—This plot consisted of approximately 0.25 ha of 'Delicious' and 'Golden Delicious' apples planted on MM-106 rootstock. The trees were 3-4m high and trained in an Italian palmette system.
- **Agricultural high school**—This plot consisted of 0.5 ha of 'Delicious' and 'Golden Delicious' apples about 3.5 m high.
- **Georgion Ion Orchard**—The demonstration plot consisted of 22 'Kalter' trees 4-5m high.
- **Costache Octavian**—The demonstration plot had 25 trees of mixed cultivars, 'Delicious', 'Jonathan', and 'Kalter', 4-5m high planted on seedling rootstock.
- **Arion Vasile**—The demonstration plot had 25 'Jonathan' apple trees, 4-5m high planted on seedling rootstock. Demonstrations were also continued in the same plots during the 1994 growing season, and one additional plot was set up.
- **Aurel Dinet**—The plot had 20 'Jonathan' and 'Wagner' trees.

All of the IPM demonstration plots were adjacent to larger plantings of apples of similar cultivars, which were treated with the cooperator's standard pesticide program.

The IPM plots were monitored throughout the season by the Romanian IPM specialist according to protocols set out in a Cornell manual, "Apple IPM, A Guide for Sampling and Managing Major Apple Pests in New York State." These protocols were used to sample for mites, spotted tentiform leafminers, white apple leafhoppers, and aphids, and to time an initial four-spray program for control of apple scab.

The seasonal development of codling moth was monitored using a heat unit accumulation model described in Extension Bulletin 1072, Cooperative Extension, College of Agriculture, Washington State University, Pullman, Washington. Sprays to control each generation were timed to coincide with the estimated hatch of 10% of the eggs of each generation. If levels of the other insect pests exceeded the recommended threshold levels or seasonal monitoring indicated that sprays were necessary, the IPM specialist would then work with the cooperator to insure that the treatments were applied.

The following pesticides were used in this program: U.S. petroleum oil#1, Systhane, captan, endosulfan, diflubenzuron, propargite, *Bacillus thuringiensis*, and malathion. These pesticides were selected because they are considered to be compatible with orchard IPM programs. These materials are not highly toxic to humans, livestock, or wildlife, and are not harmful to insect and mite predators and other beneficial insects found in orchards. Also, they are relatively non-persistent in the environment. These compounds are all registered for use on apples in Romania and other European countries.

During the spring of 1994, new orchards of scab resistant apple cultivars were planted in eight locations throughout the Curtea de Arges region. Because of the importance of apple scab in Romania, the Fruit Research Station at Voinesti has maintained a very active breeding program to select scab resistant cultivars. The following cultivars produced from this breeding program were selected for trial in the new plantings: 'Pionier', 'Generos', and 'Romus-3'. These cultivars were chosen because most of them ripen in late September or early October and the fruit can be stored for long periods of time during the winter in farmers' cellars without sophisticated temperature controls. Two additional varieties were included in this trial as world standards for comparison with the Romanian resistant cultivars: 'Fiorina', a French cultivar; and 'Prima', which was developed in the United States at Purdue University.

Larger plantings of ca 1.0 ha and 0.5 ha were established, respectively, at an agricultural high school, and at the Maracineni Research Institute for Fruit Production. Each cultivar in these plantings was planted on M-9 rootstocks, which is a very small dwarfing rootstock, and MM-106, which is a common rootstock in many apple orchards on large state farms in Romania. Trees on the M-9 rootstocks were planted 4 x 1.5 m apart and trees on the MM-106 rootstocks were planted 5 x 2.5m apart. Each of these trees was supported with a small 2.5m wooden stake attached at the top to a single wire running along each row, which was supported by cement posts 50 m apart. Trees planted on the M-9 rootstock will be trained to conform to a "Slender Spindle" planting system, which results in a pyramid shaped tree 2.3-3.0 m tall at maturity. This shape will produce high quality fruit because the tree shape allows better light penetration to improve the color, size and sugar content of apples. The MM-106 trees will be trained to a "Vertical Axis" planting system, which is usually used with slightly larger trees. This system is designed to produce a tall narrow tree. This system allows high yields with minimal pruning, but apples may be more difficult to spray and pick without ladders on these somewhat taller trees.

Smaller plantings of 180 trees of the scab-resistant<sup>1</sup> cultivars, 'Generos', 'Pionier', 'Prima', and 'Fiorina' were planted in six different private farmer's orchards. Each of these small orchards only required about 0.1 ha of land. In

these orchards, one row of 'Generos', 'Prima', and 'Pionier', was planted on the dwarfing M-9 rootstocks at a spacing of 1.5x4.0m. Another row of 'Prima' and 'Pionier' was planted on a slightly larger rootstock of M-26 at a spacing of 2.0 m x 4.0 m. Each of these trees was supported by a black locust post 2.5 m high and 7.5-10 cm in diameter. This planting system of single stakes, rather than the wire trellis, was designed to provide small farmers better access to the land around the trees if they wanted to use this area for grazing livestock or intercropping. The M-9 trees in these small plots will be trained to the slender spindle planting system previously described and the M-26 rootstocks will be trained to the "Vertical Axis" system.

In 1994, during their first year of growth, the scab resistant apple cultivars were not treated with any fungicides to control diseases. Also, since the trees did not fruit during the first season, only a minimal program of insecticides was applied to control the foliar pests that could reduce tree growth. Some of the new plantings were treated with one or two sprays of pirimicarb to control aphids during the summer, and one or two sprays of propargite to reduce mite populations. Weeds between the trees and in a 0.5 m strip on either side of the trees in the new plantings were controlled by hoeing. The trees were fertilized by applying aged cow manure in the spring and again in late summer. During this first year of planting, most of the farmers interplanted crops such as corn or potatoes in the inter-row spaces within the plantings.

## RESULTS AND DISCUSSION

### IPM in Established Plantings of Standard Apples

The general levels of apple scab pressure and insect and mite pests in areas surrounding the small IPM demonstration plots in the Romanian orchards were much higher than those normally found in similar tests conducted in the United States. These high external levels of pest populations come from several sources. First, almost every home inside or immediately outside of each small village throughout the region has at least several apple trees that are almost never sprayed at all or may be treated only sporadically with pesticides. Secondly, even in the small commercial orchards surrounding the plots, pest levels, particularly apple scab infestations of fruit and leaves, are high throughout the season because farmers are unable to adequately cover the existing large trees with their often poorly maintained hand sprayers. In addition, the farmers usually do not receive adequate information from the plant protection service to allow them to properly time sprays, and they do not have sufficient funds or access to the newer types of more active pesticides. These high levels of external pest pressure make it almost impossible to adequately control fruit damage in small plots, even when fairly large amounts of pesticide are applied.





*Comparison of 'Delicious' apples grown in a farmer's orchard treated with a standard pesticide program (top of photo) and in an IPM- demonstration plot (bottom of photo) in Romania.*

Table 1 shows that fungicides were used much more heavily in both the growers' standard orchards and the IPM plots during both 1993 and 1994 than insecticides or miticides. However, fungicide usage was reduced by about 40 to 50% in the IPM plots compared to that in the growers' standard orchards. Because of the exceedingly high levels of apple scab inoculum both within and outside the orchards in Romania, growers often fail to control the primary stages of the disease, and must continue to apply fungicides throughout the summer to prevent the secondary stages of the disease from spreading from the leaves to the fruit. In contrast, in



*Comparison of apple foliage on 'Jonathan' apple trees in an orchard treated with a standard program (left) and in an IPM-demonstration plot (right) in Romania.*

the eastern United States, where apple scab is also a serious potential problem, the growers normally are able to control the primary stages of the apple scab pathogen resulting from overwintering spores during the early part of the growing season, which negates the need for additional sprays throughout the summer. For example, in New York, growers participating in apple IPM program usually use about 7 to 9 dosage equivalents to control apple scab, which compares very favorably with the average fungicide use in the Romanian IPM plots during the 1994 season of 9.1 dosage equivalents.

**Table 1.** Comparison of pesticide usage in IPM demonstration plots and conventional small apple orchards in the Curtea de Arges area of Romania in 1993 and 1994.

Pesticide Category	Average No. of Dosage Equivalents*			
	1993		1994	
	Standard plots	IPM plots	Standard plots	IPM plots
Fungicides	22.0	12.3	21.8	9.1
Insecticides	7.0	6.6	7.3	7.3
Miticides	4.2	3.2	5.0	3.0
<b>Total Pesticides</b>	<b>33.2</b>	<b>22.1</b>	<b>34.1</b>	<b>19.4</b>

\* Dosage equivalents is a common calculation used to compare the relative amounts of different types of pesticides applied throughout a season in different agricultural systems. This calculation is particularly useful when pesticides may be applied at widely different rates.

1 Dosage Equivalent = 1 pesticide treatment at the recommended rate. 6

There was very little difference in the amount of insecticides used in the standard orchards and the IPM plots during the two years of the study. Almost all of the insecticides were used to control two insect pests which directly attack the fruit: the codling moth and San Jose Scale. The codling moth is a relatively mobile pest. Throughout the years, because of the close proximity of heavily infested trees in homeowners' yards, the potential threat from this insect and the number of control sprays required to control this pest should remain fairly constant. Infestations of San Jose Scale are usually more localized, and stringent applications of well-timed insecticides can usually virtually eliminate this pest from individual trees over a period of several seasons. Therefore, if this IPM program were to be continued in these same plots for several more years, it is very likely that the amount of sprays directed against San Jose Scale could be greatly reduced.

Even though several treatments were required during the summer, fewer miticide treatments were applied in the IPM plots than in the growers' standard orchards. The growers commonly used synthetic pyrethroids, which have been shown to cause mite outbreaks, presumably because of their toxicity to predators, in their standard orchards to control codling moths. Long-term studies conducted in New York apple orchards have shown that the exclusive use of selective pesticides that are non-toxic to predaceous mites can eventually allow these predators to increase so that miticides are no longer needed to control the European red mite. However, it may require three to five years before the predators can build up to sufficient numbers to provide effective biological control of the red mites. Therefore, it is also possible that growers in these IPM plots in Romania would be able to reduce the number of sprays of miticides to even lower levels during succeeding seasons under selective pesticide regimes.

Fruit damage from codling moth, San Jose Scale, and apple scab was substantially lower in the IPM plots than in the growers' standard orchards during both years of this study (Table 2). Also, apples in the IPM plots in 1994 were much larger than those in grower orchards, probably because the better condition of the foliage from improved scab control facilitated fruit growth. However, because of the intense

levels of external pest pressure as indicated by the high levels of fruit damage in the growers' standard orchards, infestation from apple scab was much more severe in the IPM plots than is generally acceptable in the United States. In 1994, the protocol for codling moth control in the IPM plots was changed so that only a single spray instead of two applications of diflurobenzuron was applied to control each generation according to heat unit accumulations, and this reduced schedule still provided very good control. Also, in 1994, control of San Jose scale in the IPM plots was better than that obtained in 1993, which indicated that the control strategies imposed were gradually reducing levels of the localized populations of this pest in these small plots.

### New Plantings of Scab Resistant Cultivars

All of the private farmers with small plantings and personnel in charge of the plantings at the Maracineni Research Institute were able to follow the simplified horticultural protocol for planting the scab resistant apple cultivars during the spring of the 1994 and subsequently followed through on the procedures for putting in tree support systems and selecting and training scaffold branches. Despite a lack of rainfall, the trees on all sites obtained the maximum desired terminal growth during the first season (45-60 cm). This vigorous growth indicated that the general horticultural practices practiced by the small farmers, hand cultivation of weeds within the row, intercropping in the orchard alleyways with corn, potatoes, or other vegetables, and fertilization with manure, were all compatible with the proposed cultivars and planting systems. The farmers were encouraged to utilize indigenous practices and materials whenever possible, and were quite capable of adapting local materials into the planting system. For example, they devised barriers constructed out of heavy waxed paper and plastic tubing to protect the trees over the winter from rodents and rabbits. Also, they were able to obtain black locust poles, which appear to be resistant to premature decay in the soil, for supporting the trees. When the new plantings were assessed by horticulturists in the spring of 1995, the growth and quality of the trees appeared to be comparable to those usually obtained in similar planting systems in commercial orchards in the northeastern United States.

**Table 2.** Comparison of fruit damage in the IPM demonstration plots and standard Romanian apple orchards during 1993-1994.

Year	Standard Orchards					IPM Plots				
	% Infested Fruit			% Clean fruit	Avg. apple wt. (g)	% Infested Fruit			% Clean fruit	Avg. apple wt. (g)
	Codling moth	S. J. scale	Apple scab			Codling moth	S. J. scale	Apple scab		
1993	8	26	32	—	—	0	13	13	—	—
1994	3	19	73	13	114	<1	3	48	42	166





*Two-year-old planting of scab resistant apple cultivars grafted on M-26 rootstocks.*

## SUMMARY AND CONCLUSIONS

The initial phase of this study has demonstrated that a simplified program of IPM practices and horticultural techniques can be adapted by Romanian farmers with limited resources and amounts of land. Indigenous materials and many of the traditional horticultural practices appear to be suitable for integration into improved apple production systems for producing better quality fruit than currently obtained by small farmers. The planting systems being evaluated in this project appear to be ideal for these small farms because:

- a high density of trees can be grown on small plots of land;
- farmers can utilize land between the rows for planting other crops of vegetables or even field crops such as corn;
- the small trees require only a limited amount of pruning and are easy to spray even with a hand-operated backpack sprayer;
- and the fruit is easy to harvest without using ladders or climbing the trees.

Because of the difficulty in controlling the apple scab in small plantings of traditional apple cultivars in Romania, planting scab resistant cultivars appears to be the most logical solution for the development of future low-pesticide input apple production systems.

Apple consumers in Romania are currently most familiar with the traditional cultivars 'Jonathan', 'Delicious', 'Golden Delicious' and 'Rome'. Since the Romanian consumers have not yet had the opportunity to purchase fruit from most of the scab-resistant cultivars, the acceptability and marketability of these apples is still somewhat unknown.

In order to complete this project, the new scab resistant plantings established in this project need to be monitored for at least two to three more seasons so that the management of insects and mites, susceptibility of the cultivars to other apple diseases, yields, fruit quality, and consumer acceptance and marketability can be determined. Participating farmers should also be interviewed to obtain their views on which tree training systems, and rootstocks are most acceptable to them, and how physical planting arrangements of trees should be arranged in the future. Additional studies also need to be done to determine how best to implement this technology on a larger scale among small farmers in Romania. Certainly, the lack of an adequate extension system, and the small farmers' current inability to purchase even limited inputs necessary for the implementation of these systems, such as dwarf apple trees, pesticides, and sprayers, are major constraints to the future large scale implementation of this technology. Also, if small farmers are going to be able to adequately market this fruit for relatively high prices in Romania, they must form some type of cooperative unit that will be able to produce an adequate supply of high quality fruit and be able to transport the fruit to metropolitan areas where the local market potential is greatest.

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